The Elasticity of Informality to Taxes and Transfers

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Abstract

In this work we study the impact on the size of the informal sector of a tax levied on formal workers, and transfers that may be distributed to both formal and informal workers alike. We build a search model that features an informal sector and we calibrate it to data from Mexico. We investigate whether changes in size and distribution of transfers between formal and informal workers have a significant impact on the size of the informal sector.

We find that changes in the distribution, for a given size, create a range of variation of 19.35pp. Analogously, changes in size create a range of variation of 5.7pp, resulting in a total range of variation of 51.2pp. This implies that it is possible to substantially increase formalization by rising extra tax resources as long as they accrue to formal workers. We illustrate the validity of our approach simulating the introduction of Seguro Popular.

Keywords: Informal Sector, Search, Tax and Transfer Programs, Seguro Popular
JEL Codes: E24, E26, E62, J64, J65

1 Introduction

The informal sector accounts for a large share of employment in many low-income and middle-income countries. Not firms that operate in the informal sector, nor their workers, pay taxes or social contributions [1]. As a consequence, informal workers are not enrolled in social security. A common reaction of many governments has been to introduce transfer programs directed to the informal sector to alleviate their lack of protection. In this paper we examine these type of policies to answer the following question: Can changes in taxes and transfers reduce the size of the informal sector?

As in Rauch (1991,) Edwads and Cox (2002,) and Amaral and Quintin (2006) we assume that belonging to the informal sector is a choice. Therefore, the size of the informal sector is the product of preferences and opportunities available to workers. Taxes are a strong set of incentives that may discourage labor supply and employment creation in the formal sector. Similarly, transfers that are conditional on worker's choices influence their decisions. We try to quantitatively assess the importance of this mechanism.

Our work focuses on how changes in the size of transfers and its distribution between formal and informal workers may impact the size of the informal sector. For example, imagine that 30% of transfers are currently given to informal workers (say through "Seguro Popular," which guarantees health coverage to families that are poor and informal in Mexico.) What would be the effect on the size of the informal sector of changing the size or generosity of transfers, holding the distribution of transfers between formal and informal workers constant? If transfers are biased towards formal workers, increasing their size will likely increase (decrease) the size of the formal (informal) sector. Nonetheless, this is a quantitative question. On the other hand, what would be the effect on the size of the informal sector if we were to split transfers between formal

[1] Despite what many people believe, the informal sector is included in national accounts statistics. The informal sector is measured using employment and micro-business surveys (See UN-SNA 1993).

and informal workers equally, holding the size of taxes and transfers constant? That would be akin to universalizing transfers such as health insurance. We find big effects on the distribution of employment between the formal and the informal sector.

To answer to these question we build a stylized search model in the spirit of McCall (1970.) The model features four different labor market states: employment-unemployment in the formal sector, and employment-unemployment in the informal sector. Every period an unemployed worker gets to draw a wage from both sectors[2] and decides whether to accept an offer, if any at all. Offers arrive as a Poisson's process. Employed workers may loose their job with some sector specific probability and go back to the pool of unemployed. Through distributing transfers across sectors and employment statuses, we can change the value of each choice to a forward looking worker. We calibrate the model to the Mexican economy, because it is a country with roughly 50% of the employed population working for the informal sector and it has fairly good data. However, our model could be used to assess the role of taxes and transfers in other countries, which would give a nice empirical validation or refutation of our work. In this paper we perform an exercise of validation using data from the introduction of Seguro Popular in Mexico.

In our benchmark calibration, we find that keeping the size of the tax and transfer system to 7% of GDP[3], changes in its distribution between formal and informal workers produces a range of variation in the size of the informal sector of 19.35pp. On the other hand, setting the distribution of the tax and transfer system to 30% of transfers, and changing its size produces a range of variation of 5.7pp. When we vary simultaneously its generosity and its distribution we produce a range of variation of 51.2pp at most, which is well beyond the cross country variation in the size of the informal sector.

[2]Each sector's distribution features a different mean and variance

[3]Which is roughly what the Mexican economy has been spending on social security and social transfers.

To illustrate the way our model can generate changes in informality when taxes and transfers are modified, we use the case of the recently introduced Seguro Popular in Mexico. This program is specifically designed to provide health services to informal workers. As a result, public health expenditures increased from 2.6% of GDP in 2004 (before the introduction of the program) to 3.1% in 2011 (after full implementation of the program). Moreover, the share of public health spending to informal workers increased from 30% of total spending to 45%. Thus we have a change in size and distribution of transfers. Our model predicts that this program added 1.6pp to the informal sector size. This value is consistent with the empirical evidence found by other researchers (Azuara and Marinescu (2011,) and Bosch and Campos-Vasquez (2010,) among others.) This exercise also delivers an important lesson: taking into account the size of transfers is crucial to understand the response of informality to changes in its distribution.

Our work is related to Albretch et al. (2009) and Bosch & Pretel (2011.) Both build a model similar to Mortensen & Pissarides (1994) but featuring an informal sector. In Albretch et al. (2009) workers differ ex-ante in their human capital. This is a key force to self select into unemployment or employment in either sector. Albretch et al. (2009) find that depending on their human capital there are three types of workers: those who will choose formal employment only, those who will choose informal employment only and a type of worker who would have spells into formal sector and informal sector indifferently. They study what would be the effect of changing severance payments and payroll taxes on the size of the informal sector. Compared to them, we assume that workers are ex-ante identical. As all workers are identical in our economy, the only source of selection into formal or informal sector is workers' perceptions of what taxes would they have to pay and what transfers would they get in each sector. We also assume we differentiate that unemployment depends on the sector of origin, and we provide a characterization of the tax and transfer system in greater detail. Bosch & Pretel (2011) build a model

that is closer to ours. Abstracting from the many differences in details our objective is similar, which is to measure the effects that taxes and transfers may have on the size of the informal sector. They focus on unemployment insurance, whereas we focus on a stylized tax and transfer system.

Our work is also related to a growing literature that studies the relationship between informality and aggregate outcomes. This literature, emphasizes that the fact that the informal sector is unregulated does not mean that it comes without a cost to society. At a basic level, it represents a fiscal challenge as it shrinks the potential tax base. But the informal sector may also be a barrier to economic growth and development. Informality has been related in the literature to low productivity (Cavalcanty & Antunes (2007,) Leal-Ordoñez (2009) and Moscoso & Erasmo (2010),) low human capital (La Porta & Shleifer (2008)) and higher inequality (Chong & Gradstein (2004) and Dessy & Pallage (2001.)) Thus, our results indicate that a way to reduce informality and enhance growth is through a better design of taxes and transfers.

The paper is structured as follows. Section 2 presents some key statistics computed from the 3rd and 4th quarters from ENOE 2010 and ENIGH-MCS[4]. These statistics will be key to our calibration. Section 3 lays down the model. Section 4 explains the calibration procedure to fit the statistics presented in section 2. Section 5 presents results from our numerical experiments and section 6 concludes.

2 Data and Institutional Framework

In this section we describe the structure of transfers in Mexico and present some important statistics that will be later used in our calibration. It is worth pointing out that, to some extent, these features are shared by many low-

[4] "Encuesta Nacional de Ingresos y Gastos - Modulo de condiciones socioeconómicas": National Survey of Health and Expenditures - Socio-Economic Conditions Module

income and middle-income countries, particularly in Latin America. We focus on Mexico because it has a large informal sector and statistics are of good quality. However, we believe that our model can be successfully used to other countries if similar data were available.

We need two kinds of data. We need data on transitions of workers between formal and informal sectors, labor force statuses (employed and unemployed) and wages. For this, we use third and fourth quarters of Encuesta Nacional de Ocupación y Empleo (ENOE) which has a rotating panel structure and it is representative at the national level. Using ENOE we construct transition probabilities and its induced stationary distribution of workers. We need data on transfers as well, as it will be important in our calibration the size of the transfer system and how those transfers are distributed between formal and informal workers. We use a combination of data sources.

2.1 Evidence from ENOE

We use data on employment and wages from 3rd and 4th quarters of ENOE. To define what an informal worker is, we use a question that inquires whether the worker is enrolled in Mexican social security (Mexican Institute of Social Security or IMSS.) Under the Mexican Law, employers are responsible to enroll workers into social security, but employers themselves are not required to enroll in the IMSS, nor self-employed. Therefore we drop employers and self employed from our data[5].

We define a formal employee as one that is paying social contributions. Unemployment by sector is defined by tracking workers in the sample that were formal (informal) employees and suffered a unemployment spell. Table 1 shows the transition from employment to unemployment across sectors, where $e_{F,t}$, $e_{I,t}$, $u_{F,t}$ and $u_{I,t}$ indicate the sector which a worker belongs to, in quarter t.

[5]Extending ours analysis to self employment decisions would be a natural extension of our model, we leave it for future research.

TABLE 1. Labor Market Transition Matrix

	$e_{F,t+1}$	$e_{I,t+1}$	$u_{F,t+1}$	$u_{I,t+1}$
$e_{F,t}$	.87	.10	.03	0
$e_{I,t}$	.08	.88	0	.04
$u_{F,t}$	.41	.30	.29	0
$u_{I,t}$	.20	.62	0	.18

Naming this matrix as P we can find the stationary distribution of employment and unemployment by sector that this matrix implies. Using some linear algebra we can find it by solving:

$$(I - P)v = 0$$

where v is an eigenvector.[6] Table 2 shows the stationary distribution of employment and unemployment across sectors. We also provide information on averages and standard deviations of wages per hour.

TABLE 2. Labor Force Statistics

Sector	e^*	u^*	μ_w	σ_w
F	.419	.024	31.69	31.63
I	.539	.025	21.06	24.24

According to our data, informal employment is 56.2% of total employment. We also find an aggregate unemployment rate of 5%, that divides equally across sectors. As it would be expected, average wages and the standard deviations are higher for formal workers than informal workers. Note that these are differences in observed wages. Later we find that the underlying distributions from which workers draw wage offers is rather different, which allows us to correct for selection bias, using our structural model.

[6] Alternatively, we could have used an average of the distribution of workers in the ENOE data. Both methods give similar numbers.

2.2 Size and distribution of transfers

Mexico has two competing transfer systems: social security and social transfers. Social security transfers are those provided by IMSS and consist of health insurance, retirement pensions, disability insurance, housing loans, work risk and injury insurance, day care services, sports and cultural facilities and life insurance. These transfers are funded through a payroll tax that we assume constant and we set to match the share of transfers over GDP in our calibration[7]. One of the main features of this transfer system is that transfers are bundled so either you get all transfers or none. Therefore we can sum their cash value and use it as a measure of transfers to formal workers.

Informal workers, on the other hand, are beneficiaries of a competing transfer system made up of several unlinked transfer programs that include cash and in kind transfers. Among the most important, we have Seguro Popular, which was introduced in 2004. Another example of a sizable program would be Progresa-Oportunidades, which was introduced in the nineties. In section 6 we provide a quantitative assessment of the introduction of Seguro Popular on the size of the informal sector.

To obtain the size of transfers, there are easily available data at the aggregate level on the Social Expenditure database of the OECD (SOCX.) This database reports that total social expenditure was 7.7% of GDP in 2011. This includes both cash and in kind benefits. However the SOCX database does not consider how much of transfers accrue to informal workers. Recent work has focused on documenting the distribution of transfers across income quintiles, this is an informative statistic as lower income quintiles are associated with being in the informal sector. Breceda et al. (2008) report that 30% of transfers are directed to the lowest two income quintiles. An alternative to calculate the distribution of transfers is to use data from Levy (2008.) He estimates that an

[7]In the real world, payroll taxes are regressive as they a lump sum component. As a consquence, the lowest 10% earners pay a similar fraction of their wages than top 10% earners.

informal worker gets 5670 MXP out of 24519 MXP, or 23% of total transfers. We postpone a discussion of the data for Seguro Popular to Section 6.

3 Model

To study the effects of the structure of taxes and transfers in Mexico, we build a very stylized search model that features employment and unemployment states by sector, formal and informal, potentially different wage offer distributions, and different exogenous job creation and job destruction rates[8].

The economy is populated with a continuum of risk-neutral workers that discount consumption streams at a rate β. The model period is a quarter. Workers are ex-ante identical but face random draws from two different, and independent, distributions of wage offers. G_F is the distribution of wage offers in the formal sector and G_I is the distribution of wage offers in the informal sector. We abstract from subindex t as we will be analyzing steady state allocations. The individual state variables are employment status (employed or unemployed,) employment sector (formal or informal) and current wage (w_F or w_I.) Employed workers face an exogenous sector specific separation probability, λ_i where $i \in \{F, I\}$. At this stage we abstract from on the job search. Thus, observed transitions from formal to informal employment and vice-versa include a period of unemployment.

Workers employed in the formal sector have to pay a proportional tax on wages τw_F whereas those employed in the informal sector do not pay taxes. We keep a very simple structure of transfers in the model. Formal workers receive a fraction θ of the tax proceeds as a per capita transfer: Ω_F, and this transfer is the same regardless of the employment/unemployment status. We think of this transfer as the cash value of all cash and in-kind benefits accrued to formal workers: health insurance, retirement benefits, unemployment in-

[8]A natural step in our future research would be to extend this model to general equilibrium.

surance, and so on. Informal workers get the remaining fraction $1-\theta$ of tax revenue as a per capita transfer Ω_I. These may include welfare programs that are specially targeted to them, such as *Seguro Popular and Oportunidades* and we also assume these transfers are the same across employment/unemployment status.

Every period unemployed workers get a draw from both formal and informal sector wage distributions with independent probabilities q_i where $i \in \{F, I\}$. They must choose whether they remain unemployed or accept any of the offers at hand[9]. We write down Bellman Equations that characterize the decision of workers and lay out an equilibrium definition. For that we need to characterize the steady state equilibrium level of employment and unemployment in the formal and informal sectors, and the steady state distributions of accepted wage offers in both sectors.

3.1 Value functions

The decision problem of an individual is characterized by four Bellman Equations: the value of being employed in the formal sector with a wage w_F, $V_F(w_F)$, the value of being employed in the informal sector with a wage w_I, $V_I(w_I)$, the value of being unemployed in the formal sector with wage w_F, $U_F(w_F)$ and the value of being unemployed from the informal sector with wage w_I, $U_I(w_I)$[10]

1. Value of being employed in the formal sector:

$$V_F(w_F) = \Omega_{F,e} + (1-\tau)w_F + \beta\left[\lambda_F U_F(w_F) + (1-\lambda_F)\, V_F(w_F)\right] \quad (1)$$

[9] In a model similar to ours, Bosch & Pretel allow for one offer at a time and quitting.

[10] The values of unemployment depend on wages only through transfers. If transfers are independent from wages then values of unemployment are scalars.

2. Value of being employed in the informal sector

$$V_I(w_I) = \Omega_{I,e} + w_I + \beta \left[\lambda_I U_I(w_I) + (1 - \lambda_I) V_I(w_I)\right] \tag{2}$$

3. Value of being unemployed in the formal sector

$$\begin{aligned} U_F(w_F) = \Omega_{F,u} + \eta w_F + \beta \left[q_F q_I E \max\left\{V_F(w'_F), V_I(w'_I), U_F(w_F)\right\}\right. \\ +q_F(1-q_I) E \max\left\{V_F(w'_F), U_F(w_F)\right\} \\ \left. + q_I(1-q_F) E \max\left\{V_I(w'_I), U_F(w_F)\right\} + (1-q_F)(1-q_I) U_F(w_F)\right] \end{aligned} \tag{3}$$

where η refers to unemployment insurance.

4. Value of being unemployed in the informal sector

$$\begin{aligned} U_I(w_I) = \Omega_{I,u} + \beta \left[q_F q_I E \max\left\{V_F(w'_F), V_I(w'_I), U_I(w_I)\right\}\right. \\ +q_F(1-q_I) E \max\left\{V_F(w'_F), U_I(w_I)\right\} \\ \left. +q_I(1-q_F) E \max\left\{V_I(w'_I), U_I(w_I)\right\} + (1-q_F)(1-q_I) U_I(w_I)\right] \end{aligned} \tag{4}$$

where $\Omega_{i,j}$ is the transfer that workers in sector $i \in \{F, I\}$ get when his labor force status is $j \in \{e, u\}$.

We acknowledge that unemployment benefits are not granted forever. We solve the model under two cases: unemployment and severance payments granted forever and when they are given just for the first period. Note that they can be actuarially adjusted so they have the same present value than schemes usually found across countries. Bosch & Pretel (2011) solve this issue by introducing a poisson process for unemployment duration but that would increase the number of value functions and reservation values to be solved in equilibrium[11].

[11] Actuarial adjustment would work as follows. Imagine we have a unemployment scheme that last D periods with potentially different replacement rates $\eta_1, ..., \eta_D$. The permanent value of this scheme will be:

$$\bar{\eta} = (1 - \beta) \sum_{d=1}^{D} \beta^{d-1} Prob(t = d) \eta_d$$

The value functions in equilibrium define reservation wages. These will be critical in determining equilibrium flows between employment and unemployment in both formal and informal sectors. Note that we will have four different reservation wages: a reservation wage of a unemployed worker from formal sector facing an offer from formal sector (w^R_{FF},) a reservation wage of a unemployed worker from informal sector facing an offer from formal sector (w^R_{IF},) a reservation wage of a unemployed worker from formal sector facing an offer from informal sector (w^R_{FI}) and a reservation wage of a unemployed worker previously in the informal sector that evaluates an offer in the informal sector: w^R_{II}. To define these reservation wages we use (1) to (4.)

$$V_F\left(w^R_{FF}\right) = U_F\left(w^R_{FF}\right) \quad (5)$$
$$V_I\left(w^R_{II}\right) = U_I\left(w^R_{II}\right) \quad (6)$$
$$V_F\left(w^R_{IF}\right) = U_I\left(w^R_{IF}\right) \quad (7)$$
$$V_I\left(w^R_{FI}\right) = U_F\left(w^R_{FI}\right) \quad (8)$$

3.2 Steady State Employment, Unemployment and Wage Distributions

With the reservation wages we are able to define the steady state levels of employment and unemployment and then stationary wage distributions in the formal and informal sectors. Let e^F_t be the employment in the formal sector at date t. Similarly we can define e^I_t, u^F_t and u^I_t. The evolution of these variables is driven by reservation wages, distributions of wage offers, and separation and wage drawing probabilities.

The evolution of these aggregate variables is defined by the following set of difference equations:

where $Prob(t = d)$ is the probability that unemployment duration t last for d periods, and can be computed from equilibrium value functions. We are comparing what we get with different approaches.

$$
\begin{aligned}
e_{F,t+1} &= (1-\lambda_F)e_{F,t} + q_F(1-q_I)\left[Prob\left(V_F > U_F\right)u_{F,t} + Prob\left(V_F > U_I\right)u_{I,t}\right] \\
&+ q_F q_I\left[Prob\left(V_F > U_F\right)Prob\left(V_I > U_F\right))Prob\left(V_F > V_I\right)u_{F,t}\right. \\
&+ \left. Prob\left(V_F > U_I\right))Prob\left(V_I > U_I\right)Prob\left(V_F > V_I\right)u_{I,t}\right] \\
\\
e_{I,t+1} &= (1-\lambda_I)e_{I,t} + q_I(1-q_F)\left[Prob\left(V_I > U_F\right))u_{F,t} + Prob\left(V_I > U_I\right)u_{I,t}\right] \\
&+ q_F q_I\left[Prob\left(V_F > U_F\right))Prob\left(V_I > U_F\right))Prob\left(V_I > V_F\right)u_{F,t}\right. \\
&+ \left. Prob\left(V_F > U_F\right)Prob\left(V_I > U_I\right)Prob\left(V_I > V_F\right)u_{I,t}\right] \\
\\
u_{F,t+1} &= \left[(1-q_F)(1-q_I) + q_F(1-q_I)Prob\left(V_F \leq U_F\right) + q_I(1-q_F)Prob\left(V_I \leq U_F\right)\right. \\
&+ \left. q_F q_I Prob\left(V_F \leq U_F\right)Prob\left(V_I \leq U_F\right)\right]u_{F,t} + \lambda_F e_{F,t} \\
\\
1 &= e_{F,t+1} + e_{I,t+1} + u_{F,t+1} + u_{I,t+1}
\end{aligned}
$$

Consider the first equation that define employment in the formal sector next period. The first component is the mass of workers whom did not loose their formal employment. The second component are those workers that accept an offer from the formal sector. Finally, we have unemployed workers in the formal and informal sector that get acceptable offers from both sectors; but formal sector offer dominates. Second equation follows a similar logic. Third and forth equations describe the evolution of unemployment in formal and informal sectors. Consider the third equation. Formal unemployment rate tomorrow is the sum of those formal workers that do not get an offer, plus those that get offers but reject them. Finally there is an inflow of workers that lost their employment in the formal sector. This system of equations define a steady state for employment and unemployment distributions. Key to define steady state employment and unemployment by sector in equilibrium are the probabilities that compare different offers. In the calibration we will assume log-normality of distributions from where workers draw offers, which

will make easy to compute these probabilities. As wage draws from formal and informal sector belong to different log-normal distributions there is not an analytic solution to $Prob(V_F > V_I)$. We log-linearize each value function around its respective mean wage.

$$V_F(w_F)|_{\mu_F} \longrightarrow N\left(\frac{(1-\tau)e^{\mu_F}+\beta\lambda_F U_F}{1-\beta(1-\lambda_F)}, \left[\frac{(1-\tau)e^{\mu_F}}{1-\beta(1-\lambda_F)}\right]^2 \sigma_F^2\right)$$

$$V_I(w_I)|_{\mu_I} \longrightarrow N\left(\frac{e^{\mu_I}+\beta\lambda_I U_I}{1-\beta(1-\lambda_I)}, \left[\frac{e^{\mu_I}}{1-\beta(1-\lambda_I)}\right]^2 \sigma_I^2\right)$$

$$V_F(w_F)|_{\mu_F} - V_I(w_I)|_{\mu_I} \longrightarrow N\left(\frac{(1-\tau)e^{\mu_F}+\beta\lambda_F U_F}{1-\beta(1-\lambda_F)} - \frac{e^{\mu_I}+\beta\lambda_I U_I}{1-\beta(1-\lambda_I)}, \left[\frac{(1-\tau)e^{\mu_F}}{1-\beta(1-\lambda_F)}\right]^2 \sigma_F^2 + \left[\frac{e^{\mu_I}}{1-\beta(1-\lambda_I)}\right]^2 \sigma_I^2\right)$$

We need to define the equilibrium distribution of accepted wage offers. These can be computed from the primitive distribution of wage offers and individual behavior. $\Gamma_{F,t}$ and $\Gamma_{I,t}$ are equilibrium distributions of accepted wage offers on each sector:

$$\begin{aligned}
\Gamma_{F,t+1}(w_F) &= (1-\lambda_F)\Gamma_{F,t}(w_F) + q_F q_I g_F(w_F)\left[I(w_F > w_{FF}^R) Pr(V_I > U_F)\right. \\
&+ Pr(V_F(w_F) > V_I) u_{F,t} + I(w_F > w_{IF}^R) Pr(V_I > U_I) Pr(V_F(w_F) > V_I) u_{I,t} \\
&+ \left. I(w_F > w_{FF}^R) Pr(V_I < U_F) u_{F,t} + I(w_F > w_{IF}^R) Pr(V_I < U_I) u_{I,t}\right] \\
&+ q_F(1-q_I)\left[I(w_F > w_{FF}^R) u_{F,t} + I(w_F > w_{IF}^R) u_{I,t}\right]
\end{aligned}$$

$$\begin{aligned}
\Gamma_{I,t+1}(w_I) &= (1-\lambda_I)\Gamma_{I,t}(w_I) + q_F q_I g_F(w_F)\left[I(w_I > w_{FI}^R)Pr(V_I > U_F)\right. \\
&+ Pr(V_I(w_I) > V_F)u_{F,t} + I(w_I > w_{II}^R)Pr(V_F > U_I)Pr(V_I(w_I) > V_F)u_{I,t} \\
&+ \left. I(w_I > w_{FI}^R)Pr(V_F < U_F)u_{F,t} + I(w_I > w_{II}^R)Pr(V_F < U_I)u_{I,t}\right] \\
&+ q_F(1-q_I)\left[I(w_I > w_{FI}^R)u_{F,t} + I(w_I > w_{II}^R)u_{I,t}\right]
\end{aligned}$$

Each of the equations define a steady state measure of accepted wage offers: Γ_F and Γ_I. We normalize the measure of workers in the economy to one[12]. The steady state equilibrium transfer system can be defined as:

$$\Omega + \eta \int w_F d\Gamma_F = \tau \int w_F d\Gamma_F(w_F) u_F$$

which tells us that total resources collected by the government equal total transfers Ω plus what is spent on unemployment insurance. Note that $\Omega = \Omega_{F,e} + \Omega_{F,u} + \Omega_{I,e} + \Omega_{I,u}$. We assume that $\Omega_F = \theta\Omega$ and $\Omega_{i,j} = \Omega_i \frac{j_i}{u_i + e_i}$ where $i \in \{F, I\}$ and $i \in \{e, u\}$

4 Calibration

We calibrate the model by choosing parameters and simulating until we are close to some key moments from Section 2. All parameters but θ are found trough simulations. We set $\theta = .7$ based on the discussion of Section 2. The parameters we need to calibrate are job firing probabilities, job finding probabilities, and means and standard deviations of wage distributions both in formal and informal sectors. We also set transfers Ω so that in equilibrium the size of taxes and transfers equals 7% of GDP in the model economy. We

[12]This implies that $\int d\Gamma_i(w_i) = e_i$ where $i \in \{F, I\}$

assume that wage offers of formal and informal sectors are drawn from i.i.d. log-normal distributions with potentially different mean and variance

$$\log(w_i) \to N(\mu_i, \sigma_i^2) \text{ where } i \in \{F, I\}$$

This gives us nine parameters to calibrate that we collect in the vector

$$\varphi = (\lambda_F, \lambda_I, q_F, q_I, \mu_F, \mu_I, \sigma_F, \sigma_I, \tau)$$

We chose the vector of parameters that minimized the mean squared percent deviation from the moments selected. The statistics we choose are the fraction of employees in the formal sector $\hat{e}_F$, the fraction of employees in the informal sector $\hat{e}_I$, total unemployment $\hat{u}$, unemployment in the informal sector $\hat{u}_I$, mean wage in the formal sector $\bar{w}_F$, mean wage in the informal sector $\bar{w}_I$, the standard deviation of wages in the formal sector σ_F, the standard deviation of wages in the informal sector σ_I and the share of transfers of GDP $\frac{Tr}{y}$[13]

The following table shows the vector of parameters that minimized the mean squared deviation of the simulated moments to their ENOE equivalents Firing probability in the formal sector is smaller than in the informal sector.

TABLE 3. Calibrated Parameters

λ_F	λ_I	q_F	q_I	μ_F	μ_I	σ_F	σ_F	Ω
.0233	.0348	.3314	.9116	2.8096	2.0596	.9254	1.0593	3.6908

This is what we expected as the formal sector in mexico is subject to high severance payments. Similarly, job finding probabilities are smaller in the formal sector than in the informal sector. Mean wages in the formal sector are bigger than mean wages in the informal sector. We also expect this result but when we compare wages in the formal sector relative to wages in the informal sector in the data and the model we observe that the informality gap close by 7.35pp. We interpret this result as informal sector not being as unproductive

[13]In our model $y = \int w_F d\Gamma_F + \int w_I d\Gamma_I$

relative to the formal sector as what would have measured from raw data. This parameters should be interpreted carefully until we have a general equilibrium version of the model, where job finding and job destruction probabilities will be endogenously given and we will be able to back up productivities.

These estimated parameters induce the following moments that we compare to those in the data in the next table.

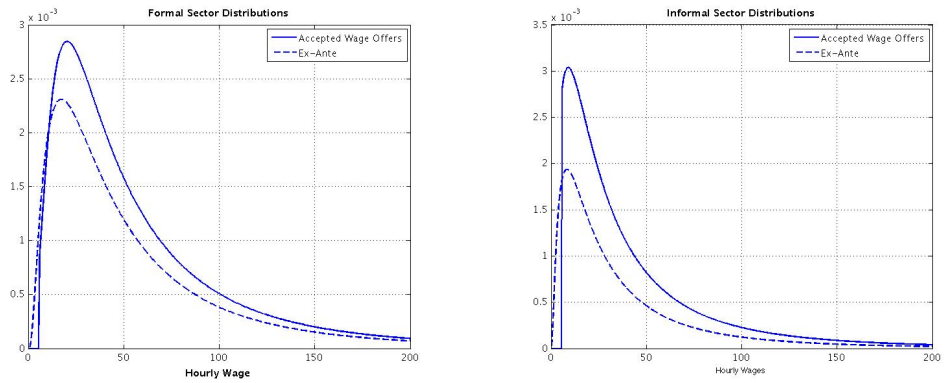
TABLE 4. Fit of Moments

	e_F	e_I	u	u_I	$\bar{w}_F$	$\bar{w}_I$	σ_F	σ_I	$\frac{Tr}{y}$
Data	.42	.54	.04	.02	31.69	21.06	31.63	24.04	.07
Model	.4198	.5385	.0417	.0274	31.38	21.32	31.75	24.04	.07

The model provides a good match of employment and unemployment. It is also very accurate in capturing the first two moments of the observed distribution of wages. It also gives a decent approximation to wage inequality in Mexico. OECD reports a Gini coefficient around .45. Our model's Gini coefficient is .4268 for formal workers and .4338 for informal workers. This is not surprising as we are targeting mean and standard deviation in formal and informal sectors, and the distribution of wages in the data is likely log-normal. However, since the fit of moments is good we can be relatively confident when we simulate different policy changes that we will be doing comparative statics with current Mexican economy as a benchmark.

Figure 1 plots the distribution of accepted wage offers in the formal (a) and informal sectors (b). We observe substantial differences between ex-ante and ex-post distributions. Selection into formal and informal employment tilts the distribution of accepted wage offers to the right of the ex-ante distribution of wage offers.

FIGURE 1. Distribution of Wages in the Formal and Informal Sector



(a) Formal Sector

(b) Informal Sector

5 Policy Simulations

In this section we analyze three policy reforms: changing generosity of the transfers system, changing distribution of transfers between formal and informal workers and the introduction of unemployment insurance for formal workers, which is one proposal in the policy agenda of Mexico current government.

5.1 Changes in Distribution of Transfers

We will keep taxes constant at the benchmark level of 28%[14] but change the distribution of transfers between formal and informal workers. Starting from the benchmark assumption in which formal workers get all the transfers when they become unemployed, we increase the share that informal workers get from the transfer system.

Dividing transfers equally between formal and informal workers increases the share of the informal sector by 5pp compared to the benchmark economy where the share of transfers is 70-30, as we can see in Table 5. Analyzing this

[14]This is the tax rate that in equilibrium delivers a ratio of transfers to GDP of 7%

policy reform is relevant because it is similar to universalization of social[15], another topic currently discussed in Mexico nowadays. Note that this policy will reduce unemployment in the formal sector as less workers will be queuing in formal unemployment to get a formal sector offer, at the cost of increasing unemployment in the informal sector. However, total unemployment is neutral to this policy change.

TABLE 5. Changes in Distribution

θ	1	.8	.7	.5	.3	.1
e_F	.4804	.4415	.4201	.3743	.3255	.2729
e_I	.4778	.5167	.5381	.5840	.6330	.6858
u_F	.0168	.0152	.0143	.0125	.0106	.0087
u_I	.0250	.0266	.0274	.0291	.0308	.0326
$\bar{w}_F$	29.2730	30.5928	31.3592	33.1567	35.3265	38.0977
$\bar{w}_I$	22.6091	21.7752	21.3356	20.4669	19.6015	18.7510
σ_F	30.9929	31.4525	31.7271	32.3863	33.2225	34.3495
σ_I	24.7815	24.2944	24.0374	23.5214	23.0024	22.4818

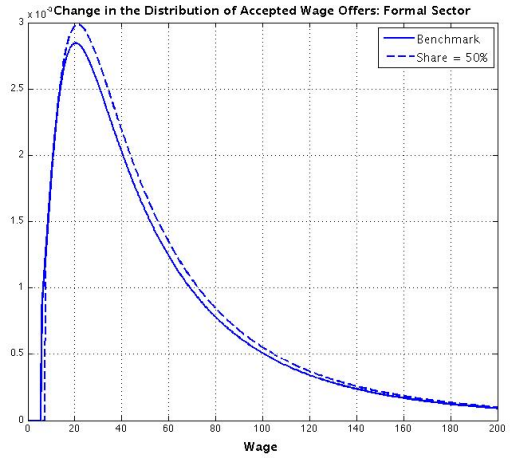
Changing the distribution of transfers has effects on the wage distribution as well, changing the distribution of accepted wage offers in both formal and informal sectors. The whole effect in our model goes through changes in reservation wages. We observe a rise in formal sector mean wages and its dispersion, whereas informal mean wages drop, increasing the informality gap.

5.2 Changes in the Generosity of the Transfers

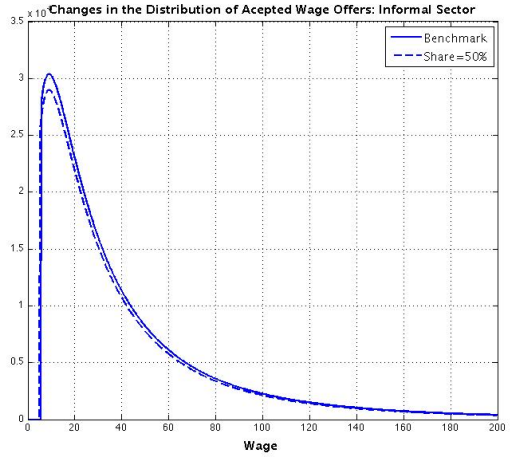
We will change the size of the transfer system to make it 50% less generous and 50% more generous than the benchmark generosity. As we are imposing a balanced budget this is equivalent to changing the tax rate on wages too, in the same proportion. The effects of increasing the size of the transfer system are

[15]It is similar because the benchmark economy delivers 50% of workers in the informal sector

FIGURE 2. Changes in Distribution of Transfers and Distribution of Wages



(a) Formal Sector



(b) Informal Sector

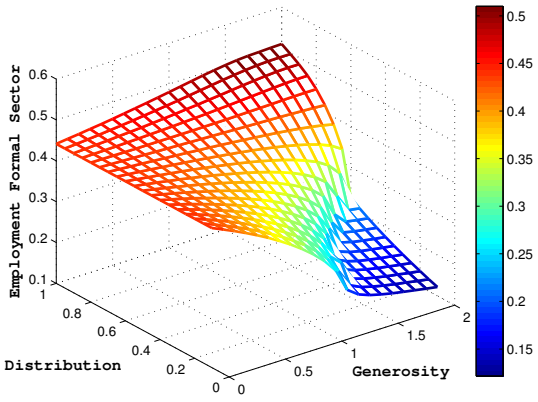
small for the distribution of employment and unemployment, conditional on the distribution of transfers. This gives us a clear policy prescription: changing distribution of tax and transfer programs between formal and informal sectors is much more effective than increasing its generosity given the benchmark distribution of transfers. However, it would be most effective shifting the distribution of transfers to the formal sector while radically increasing its

generosity.

TABLE 6. Changes in Generosity

Ω	.5	.8	1	1.3	1.5
e_F	.4311	.4248	.4201	.4115	.4059
e_I	.5262	.5330	.5381	.5474	.5533
u_F	.0151	.0147	.0143	.0138	.0134
u_I	.0276	.0275	.0274	.0274	.0273
$\bar{w}_F$	31.3272	31.3455	31.3592	31.4120	31.4336
$\bar{w}_I$	21.8378	21.5442	21.3356	21.0070	20.8318
σ_F	31.5620	31.6491	31.7271	31.8967	32.0454
σ_I	24.2164	24.1156	24.0374	23.8950	23.8011

This does not mean that changes in generosity for different distributions of taxes and transfers would have a big effect on the size of the informal sector. Figure 3 illustrate this fact.

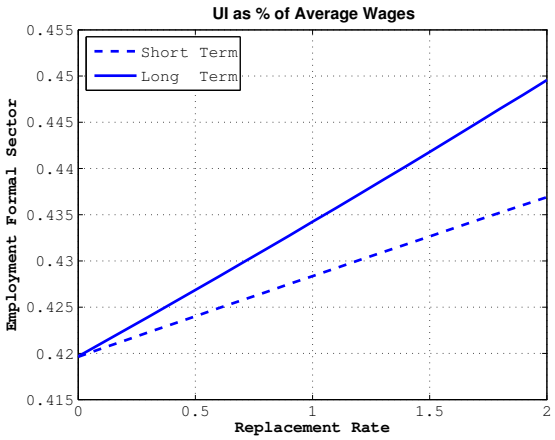


5.3 Unemployment Insurance

In this section we introduce unemployment insurance as a replacement rate η of average wages in the formal sector. We vary replacement rate from 0 to 200% of average wages. To study the importance of giving unemployment insurance for a long period of time versus a short period of time we make two

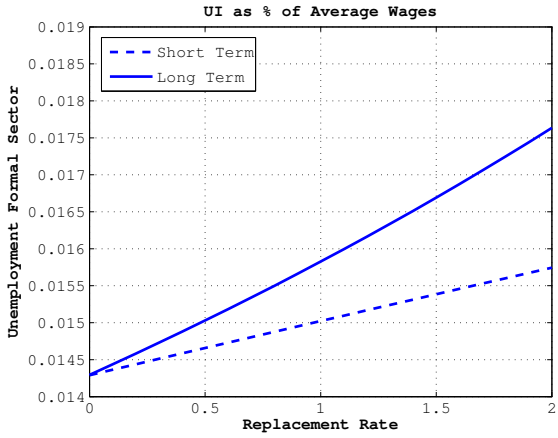
extreme assumptions: unemployment insurance lasts for one period and unemployment insurance lasts for as long as you are unemployed. These policies imply minor changes on the value functions of unemployment but does not change the structure of the model described in previous sections.

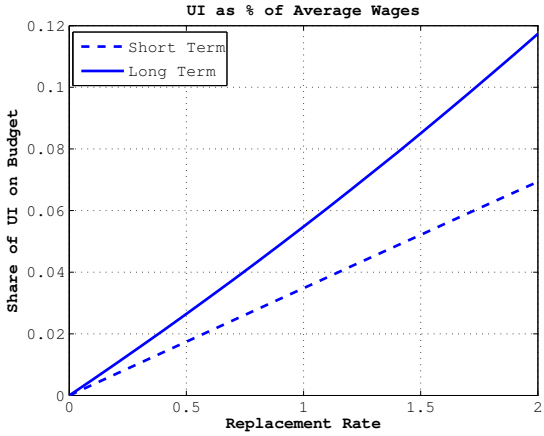
We can see that unemployment insurance has relatively small effects on the size of the formal sector. This is due to the fact that the relative size of this program over the pre-existing tax and transfer system is relatively small. We have to take this result carefully as we are not dealing with general equilibrium effects. We are also abstracting from perverse incentives that would encourage workers to claim benefits when they are laid off from the formal sector, while working in the informal sector.



6 The case of Seguro Popular

In this section, we illustrate our main results using the case of the recently introduced "Seguro Popular" in Mexico. Seguro Popular is a program designed to provide health services to people not covered by the traditional social security system. The introduction of "Seguro Popular" represents a huge increase in the transfers devoted to informal workers, taking into account that the share of social transfers over GDP did not increase dramatically for Mexico.


UI as % of Average Wages
Short Term
Long Term
Unemployment Formal Sector
0.019
0.0185
0.018
0.0175
0.017
0.0165
0.016
0.0155
0.015
0.0145
0.014
0
0.5
1
1.5
2
Replacement Rate


UI as % of Average Wages
Short Term
Long Term
Share of UI on Budget
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.5
1
1.5
2
Replacement Rate

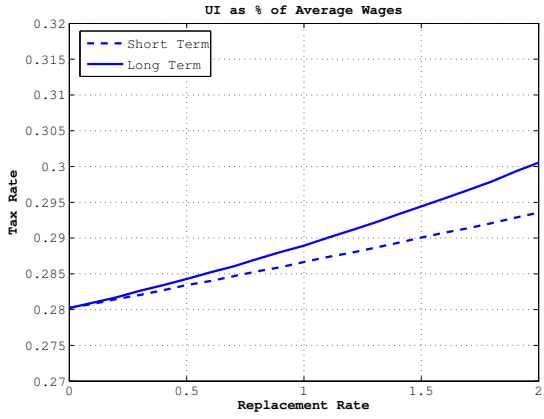
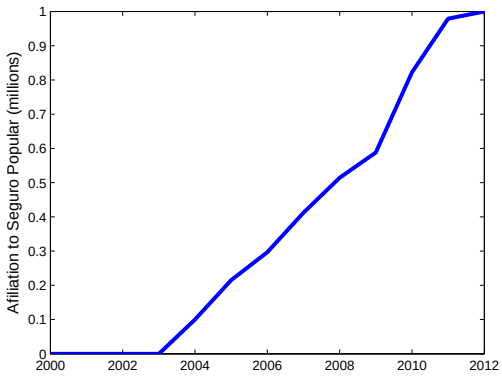

UI as % of Average Wages
Short Term
Long Term
Tax Rate
0.32
0.315
0.31
0.305
0.3
0.295
0.29
0.285
0.28
0.275
0.27
0
0.5
1
1.5
2
Replacement Rate

FIGURE 3. Affiliation to Seguro Popular



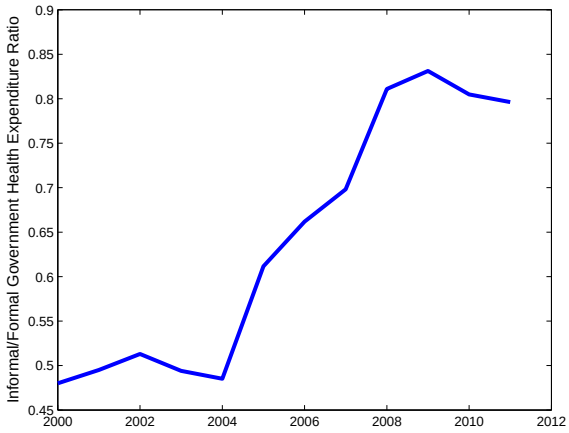
Source: Sistema de Proteccion Social en Salud. Informe de Resultados 2012.

The program was gradually introduced in Mexico starting in 2004 and reaching its potential in 2012. Figure 3 shows the evolution of affiliation to the system. In particular, the figure shows the cumulative number of persons registered each year as a fraction of the total number of persons registered in 2012, which is the maximum number possible. As it is clear from the figure, at the beginning of 2009 more than 50% of potential affiliation had already taken place, and by the end of 2010 82% was enrolled. Thus, in 2009 the size of the program was already sufficiently large to affect the incentives of Mexican workers.

As a result of the introduction of Seguro Popular, government health spending increased from 2.6% of GDP to 3.1% in the period. But more importantly, the composition of expenditures across the formal and informal sectors changed (See Figure 4). Government spending on health programs devoted to informal workers increased from 32% of total spending in 2004 to 45% in 2011. Thus, the size of aggregate transfers is now more or less the same across the formal and informal sectors.

We find similar trends when we measure variables in per capita terms. Per capita spending on formal workers and their families has remained fairly constant since 2000, while spending directed to informal workers has increased.

FIGURE 4. Informal/Formal Government Health Expenditure Ratio



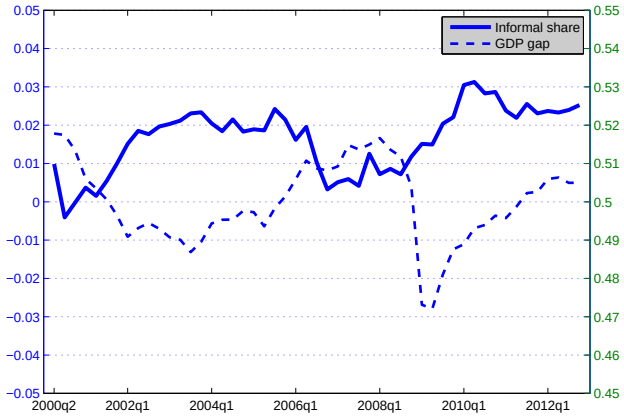
Data source: Ministry of Health .

In 2004, for each peso spent on health services directed to informal workers and their families, the government spent 2.4 pesos on health directed to formal workers and their families. In 2011 this ratio was only 1.5 pesos[16].

Is there any evidence in the data that this change in the size and distribution of taxes and transfers has induced changes in informality and/or unemployment? To answer this question we look at time series data of these two variables and the cyclical component of GDP. These are presented in Figures 5, 6, 7 and 8. Figure 5 presents the share of informality among employees and Figure 6 the share of informality among all workers. Notice that both measures of informality increase in 2009 and stay high until 2012. The increase in 2009 can be attributed, at least partially, to the severe contraction that the Mexican economy experienced that year. Nonetheless, informality has stayed high since then, while GDP has returned to trend. Something similar has happened to unemployment as illustrated in Figure 7. Nonetheless, in the case of unemployment, there exists a clear trend (Figure 8). If "Seguro Popular" had an impact on unemployment, this should be picked up by changes in the trend. The slope of this trend decreases in 2004, increases in 2007, and is

[16]The source of this data is the Mexican Ministry of Health (Secretaria de Salud)

FIGURE 5. Evolution of informality among employees



Source: Own calculation using ENE, ENOE and National Accounts.

TABLE 7. Data on distribution and generosity of transfers associated to the introduction of Seguro Popular

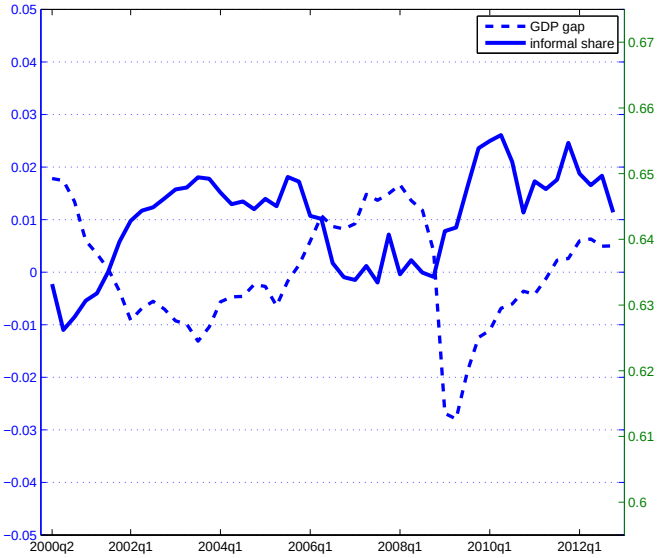
Data	2004	2011
Health Spending / GDP (Generosity)	2.59	3.05
Share of spending directed to formal workers (Distribution)	0.6756	0.5567

reduced again in 2011; thus, we don't see a clear change in trend in the period in which the program was introduced.

We proceed to use our model to quantitatively assess the impact of Seguro Popular. To do this, we use data on government health expenditures before and after the introduction of Seguro Popular. We calibrate the model to the data on health expenditures in 2011 after the program was fully introduced. Then, we simulate in the model a reduction in generosity of 15% along with a change in the distribution of transfers towards formal workers (see Table 7). The new steady state would correspond to the situation before the introduction of the program.

The results are presented in Table 8. Our model predicts that the impact of Seguro Popular was to increase the share of informality in 1.65 percentage points. This result is consistent with previous literature that has reported a

FIGURE 6. Evolution of informality among all workers

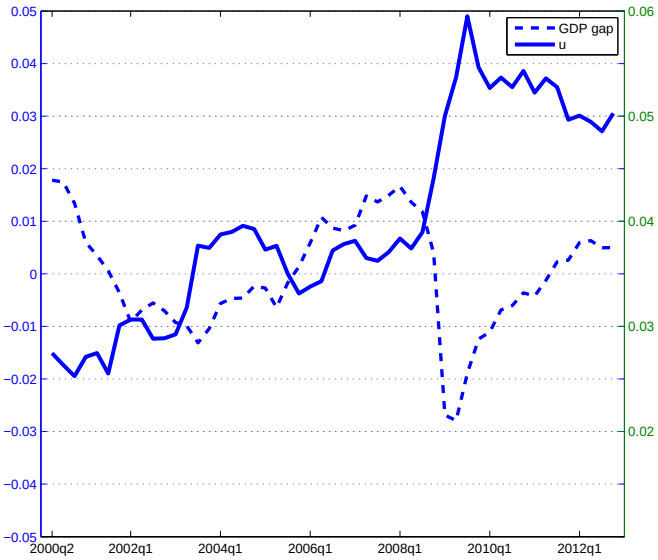


Source: Own calculation using ENE, ENOE and National Accounts.

small effect of the introduction of this program on informality (Azuara and Marinescu (2011) and Campos (2011,) among others). Our model also predicts a small reduction in the unemployment rate of only 0.005pp. We believe that this is consistent with the evolution of unemployment in Figure 8, in particular, with the fact that there has been no clear changes in trend.

The small changes found as a result of the introduction of SP are the result of their small size relative to the value of work and unemployment. Thus, a lesson from this exercise is that in order to obtain big changes in informality, transfers should be much bigger. However the purpose of this exercise is not to study the impact of Seguro Popular on informal labor markets but to address whether our model is able to quantitatively predict well documented changes in the structure of tax and transfer programs in Mexico. Given that, our model predicts substantial effects on the size of the informal sector for radical changes to the structure of tax and transfer programs.

FIGURE 7. Evolution of unemployment



Source: Own calculation using ENE, ENOE and National Accounts.

FIGURE 8. Unemployment trend

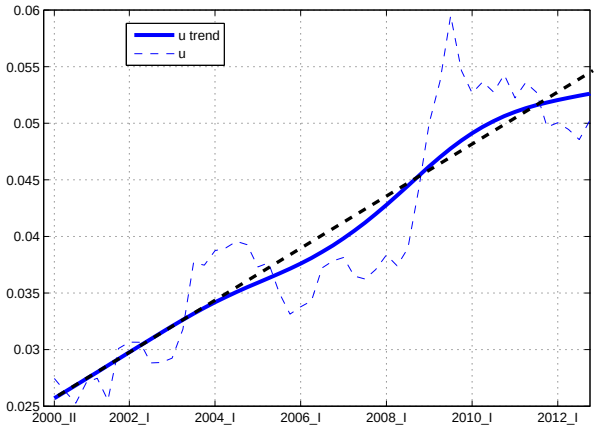


TABLE 8. Impact of the introduction of Seguro Popular in informality and unemployment

	Without Seguro Popular	With Seguro Popular	Difference
e_I	0.5224	0.5389	0.0165
u	0.0425	0.042	-0.0005
u_F	0.0156	0.0148	-0.0008
u_I	0.0269	0.0273	0.0004

7 Conclusion

We have built a search model that features four different labor market states to capture the choice of workers to be employed in the formal or informal sectors. As a consequence of their choice and current tax and transfers system, unemployment also depends on the sector they were spelled from.

We calibrate the model to Mexican data because of its relative quality, but our model may apply to other countries too. A very simple specification of the model is able to match accurately key statistics of the Mexican economy. With the calibrated version of the model we perform several simulation exercises to quantify the effects of tax and transfers policies aimed to increase the value of formality. These policies are now in the center of a vivid policy debate.

First, we find that increasing the share of transfers that flow into informal workers, while keeping total transfers fixed, increases the size of the informal sector in an important way: the range of variation is of 19 percentage points. Second, we find that increasing the generosity of the taxes and transfers system reduces the formal sector -since it bears the entire tax burden-, but it does so in a less drastic way than in the case where we only change the distribution of transfers: the range of variation in the size of informality is only 5 percentage points as a result of this change in policy. Third, when we simultaneously change both, the size and the distribution of transfers, we find a potential range of variation of 51 percentage points. This implies that the informal sector can be drastically reduced through changing the structure of the tax

and transfer system. Specifically, reducing the size of the informal sector may be achieved by increasing taxes and transfers, as long as these transfers are allocated to formal workers only.

We believe that this result is important in the light of recent discussion in Latin American countries where the elimination of the traditional social security system is being considered as a way to reduce informality. Our results suggest the opposite: that allocating more resources to the traditional social security system is an effective way to increase formalization, even if those extra resources come from higher taxes to formal workers. Moreover, our analysis implies that this process can be done without reducing the value of the transfers already received by informal workers.

One last lesson from our analysis is that in order to obtain large changes in informality, the size of transfers is crucial. As an example, we analyzed the case of the introduction of Seguro Popular in Mexico, where the distribution of public health spending towards informal workers increased from 30% to 45% of total public spending. We showed that despite this large change in the distribution of transfers, the effect on informality is small because the size of the health spending transfers is small relative to the value of jobs and unemployment. This should not be interpreted negatively, as using a well documented change in the structure of tax and transfer programs, our model is quantitatively accurate. Therefore, radical changes in the structure of tax and transfer programs in countries with high informality may reduce the size of the informal sector substantially. It is left for future research whether our model is consistent with cross country evidence.

Our model is amenable to extensions in some dimensions. Top in our research agenda is introducing education, as the response of workers to changes in taxes and transfers may be substantially different for people with different academic degrees. We also believe that we can learn more from extending our model to general equilibrium.

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